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Chemical and Mechanical Control of False Hellebore (*Veratrum californicum*) in an Alpine Community

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RESEARCH SUMMARY

In the early 1980's, trials to control false hellebore (*Veratrum californicum* Durand) were initiated on high-elevation rangeland in central Utah. Five herbicides (amitrole, picloram, glyphosate, triclopyr, and 2,4-D) and three mechanical treatments (hand cutting, rototilling, and disc chaining) were tested as potential control procedures for treatment of areas infested with false hellebore. Evaluations were conducted at 1, 2, 4, and 9 years after treatment. Stem density of false hellebore treated with herbicides was reduced 40 to 75 percent by the second year after treatment. Following this initial decrease, stem densities increased through the ninth posttreatment year. A single hand cutting appeared to weaken plants the first 2 years after treatment, but baseline stem density increased 45 percent after 9 years. Rototilling, disc chaining, and treatment with picloram provided the most control of stem densities, reducing densities by 87, 48, and 46 percent, respectively. Treatment with picloram appeared to yield the best combination of false hellebore control and community recovery.

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INTRODUCTION

False hellebore (*Veratrum californicum* Durand), also known as wild corn, cow cabbage, or veratrum, has not only continued to spread in many high-elevation grass-forb meadows, but has invaded some aspen stands in the central Rocky Mountains (Spencer and Thompson 1984). This species has two deleterious effects: (1) it is toxic to livestock, causing abortion in gestating ewes and congenital deformities in surviving lambs (James and others 1980) and (2) the clonal growth and expansion of this species on prime high-elevation sites, in response to overuse of more desirable species in the community, has substantially reduced the potential for natural recovery of desirable species.

While extensive research has been conducted on the toxicity of false hellebore (Binns and others 1963; Keeler 1969, 1990; Keeler and Stuart 1987; Knight 1989), research on false hellebore control is limited to a few herbicide trials completed during the late 1950's and mid-1960's (Klomp 1958; May and others 1968; Street and others 1967, 1968). Williams and Kreps (1970) evaluated 10 herbicides at application rates of between 4 and 12 kg active ingredient per hectare (ai/ha), reporting 55 to 95 percent control of false hellebore the first year for the four most effective herbicides. This improved to 100 percent control following a second 4-kg ai/ha treatment of the same plots the next year with the amine salt of 2,4-D. Re-evaluation of these treatments at 10 years (Williams and Cronin 1981) and 20 years (Williams 1991) indicates long-term control under proper management. Regardless of the herbicide used, the most effective time to apply herbicides for false hellebore control was just after the last leaf expanded, before the flowers began to open (Williams and Kreps 1970).

The high application rates needed for control with 2,4-D and the need for two successive years of application tend to make large-scale treatment economically unattractive. Since these trials in the 1960's, many other herbicides have been developed that have not been evaluated for control of false hellebore.

A study to test alternative herbicides and possible mechanical control methods was initiated by the technical staff of the Manti-La Sal National Forest at the Price Ranger District in the early 1980's. A dense stand of false hellebore was selected to test the following control methods:

Herbicides: Amitrole, picloram, glyphosate, triclopyr, and 2,4-D.

Mechanical: Hand cutting to ground level, rototilling, and disc chaining.

STUDY AREA

The study area is at the head of Boulger Canyon (2,896 m elevation) on the Price Ranger District. The study plots were all located on a north aspect with 5 to 10 percent slope. This area is in a perennial snowdrift site; snow sometimes covers the area until mid-July. Soils are silty clay loams, 38 to 76 cm deep. The site is grazed seasonally by sheep from July 1 to October 1.

METHODS

Plots 15 by 15 m were delimited in a dense patch of false hellebore. Control treatments (except 2,4-D and disc chaining) were applied on August 6, 1982, while plants were growing rapidly and just before their panicles opened. Plant height averaged nearly 91 cm. Temperature at the time of application ranged from 15 to 18 °C, and the air was calm. A backpack sprayer calibrated to deliver 350 L/ha of the herbicide and water solution was used for foliar application of amitrole (4 kg ai/ha), glyphosate (2 kg ai/ha), and triclopyr (2 kg ai/ha). Leaf surfaces were thoroughly wetted. Picloram pellets were hand broadcast at the rate of 1 kg ai/ha. Plants receiving the cutting treatment were cut near the soil surface using a hand sickle. The rototill treatment consisted of one pass of a gas-driven rotary tiller. Soil was tilled to a depth of 10 to 15 cm. False hellebore plant tops, rhizomes, and roots were chopped and mixed into the soil.

Three other treatments, not part of the initial design, were evaluated as part of this study. Early- and late-season treatments of 2,4-D (2 kg ai/ha) were initiated using a backpack sprayer as described above. The early-season treatment occurred in June 1981; the late-season treatment occurred in July 1983. These plots were immediately adjacent to the other herbicide plots. No baseline or interim data were collected for these treatments. The disc chaining treatment was completely independent of all preceding treatments and occurred in the drainage immediately west of the Boulger study area in September 1985. A large anchor chain with discs welded to the links was pulled in a loop behind a tracked tractor. A two way chaining across the contour of the slope provided a treatment that knocked down the standing crop and disrupted the rhizome layer of false hellebore. As with the 2,4-D treatments, no pretreatment baseline or interim data were collected for this treatment. For treatments where baseline data were not taken, the baseline was assumed to be 16.8 false hellebore stems per square meter, based on the average baseline population density for the Boulger study treatments.

For data collection, each 15- by 15-m treatment plot was subdivided into quarters and each quarter was sampled independently. Transect lines were located in the center of the treatment plot and ran the length of each quarter plot. Data were recorded from five 0.25-m^2 sample quadrats distributed at regular intervals along each transect within each quarter plot. Stem density counts for false hellebore were recorded in 1983, 1984, and 1986. Stem density for false hellebore and nested frequency data for all herbaceous species were recorded in 1991.

Nested frequency data were analyzed for the 16 species encountered often enough to allow comparisons. These data were collected at the same time as the density counts. The 0.25-m^2 sample quadrat had four divisions of increasing size. A species occurring in the smallest division received a score of 4, while those occurring first in the other divisions received a score of 3, 2, or 1, respectively, as the size division increased. No attempt will be made in this report to synthesize conclusions on a species-by-species analysis of the nested frequency data. The data are available in table 1 for treatment-by-treatment and species-by-species analysis that may be useful for other objectives.

Table 1—Nested frequency scores by treatment and species for early 1980's false hellebore treatments in Boulger Canyon. Values preceded by the same letter are not significantly different within a row; values followed by the same letter are not significantly different within a column

Species	Treatment								
	Amitrole	Picloram	Glyphosate	Triclopyr	2,4-D early	2,4-D late	Cutting	Rototilling	Disc chaining
Veratrum californicum	bc 8.8 def	bcd10.3 ef	bc 8.5 ef	bc 9.5 ef	b 8.0 cd	bcd10.3 de	cd13.3 h	a 3.0 abcd	ab 7.3 def
Descurainia pinnata	a 0.0 a	c 5.3 bcd	bc 4.3 abcde	d 9.8 ef	bc 3.8 abc	abc 2.8 ab	ab 1.5 ab	bc 3.8 abcd	d10.0 f
Thalictrum fendleri	310.8 fg	ab 0.8 a	d 6.8 cdef	abc 2.8 abc	cd 4.3 abc	ab 1.5 ab	d 6.8 efg	a 0.5 abc	abc 2.3 abc
Viola purpurea	ab 8.8 def	a 3.8 abc	a 7.5 def	a 3.0 ab	a 6.3 bc	a 2.3 ab	ab 7.8 fg	a 5.8 de	a 3.5 abcd
Bromus carinatus	ab 9.3 def	bc14.0 g	bc14.0 g	c16.5 g	a 6.5 bc	a 5.8 bcd	a 8.0 fg	a 5.5 de	a 8.3 ef
Agropyron trachycaulum	de12.5 g	e13.0 fg	cde 9.3 f	bc 7.5 de	de12.0 d	e13.0 e	bcd 8.5 g	ab 4.5 bcd	bc 6.8 cdef
Galium boreale	a 0.3 ab	abc 1.8 a	abc 2.5 abc	d11.5 f	c 6.5 bc	bc 4.0 ab	abc 1.8 abc	c 4.5 bcd	ab 0.8 ab
Helenium hoopesii	cd 7.3 de	ab 1.3 a	ab 1.8 ab	a 0.0 a	a 0.5 a	ab 1.3 ab	bc 4.8 bcdef	ab 1.5 abcd	d10.0 f
Stipa columbiana	bc 4.8 cd	c 6.3 cd	abc 2.8 abc	ab 2.3 ab	abc 3.8 abc	a 0.3 a	bc 5.0 cdef	bc 4.8 cde	abc 3.8 abcde
Rudbeckia occidentalis	abc 3.0 bc	abc 3.5 abc	bc 4.0 abcde	c 6.3 cde	abc 2.8 abc	ab 0.3 a	c 5.8 defg	a 0.0 a	abc 2.8 abcd
Hackelia floribunda	a 0.0 a	ab 1.5 a	ab 3.0 abcd	c 7.0 de	ab 0.8 a	ab 2.0 ab	ab 3.3 abcd	a 0.0 a	ab 3.0 abcd
Polemonium foliosissimum	ab 5.3 cd	ab 3.5 abc	ab 6.0 bcdef	ab 5.3 bcd	ab 4.3 abc	ab 2.3 ab	b 6.8 efg	a 1.0 abc	ab 4.8 bcde
Poa reflexa	ab 1.8 ab	c 8.0 de	c 6.8 cdef	c 5.0 bcd	c 6.8 bcd	c 5.5 bcd	bc 4.3 bcde	a 0.3 ab	a 0.0 a
Phacelia hastata	a 0.0 a	a 1.5 a	a 0.0 a	ab 2.5 ab	ab 2.3 ab	b 5.3 abcd	a 0.5 a	c13.0 f	a 0.0 a
Madia glomerata	a 0.0 a	a 2.5 ab	a 0.0 a	a 0.0 a	a 4.3 abc	b 9.5 cde	a 0.0 a	c18.8 g	a 0.0 a
Stipa lettermani	c10.0 efg	a 2.5 ab	ab 3.0 abcd	a 0.0 a	ab 3.0 abc	b 4.8 abc	ab 2.5 abcd	c 9.0 ef	a 0.0 a

Table 2—Species assignment to desirability class based on seral placement and forage potential

Desirability class		
Desirable	**Intermediate**	**Less desirable**
Agropyron trachycaulum	*Galium boreale*	*Descurainia pinnata*
Bromus carinatus	*Hackelia floribunda*	*Helenium hoopesii*
Poa reflexa	*Phacelia hastata*	*Madia glomerata*
Stipa columbiana	*Polemonium foliosissimum*	
Thalictrum fendleri	*Rudbeckia occidentalis*	
	Stipa lettermani	
	Viola purpurea	

Grouping species into classes of plants (desirable, intermediate, and less desirable) and summing their nested frequency scores (cumulative nested frequency) allowed for a more useful analysis determining treatment effects on community structure. Assignment to these classes was based on a combination of species' seral placement and their potential forage utility (table 2). Since community baseline data were not recorded, only differences among treatments may be assessed. This comparison is valid with the assumption that the baseline community was similar throughout the study area.

Standard analysis of variance and Fisher's least significant difference (LSD) mean separation procedures were employed to distinguish treatment differences in stem density and nested frequency scores.

RESULTS

The level of control achieved by the various chemical and mechanical treatments was quantified only by stem density counts. However, there were noticeable, apparent differences in stem heights and diameters between treatments.

Herbicides

Amitrole: False hellebore stem density averaged 11.5/m^2 before treatment. Stem density was reduced 21.5 percent in 1983, 44 percent in 1984, 30 percent in 1986, and 32.5 percent in 1991 (fig. 1).

Picloram: False hellebore stem density averaged 16.0/m^2 before treatment. Stem density was reduced

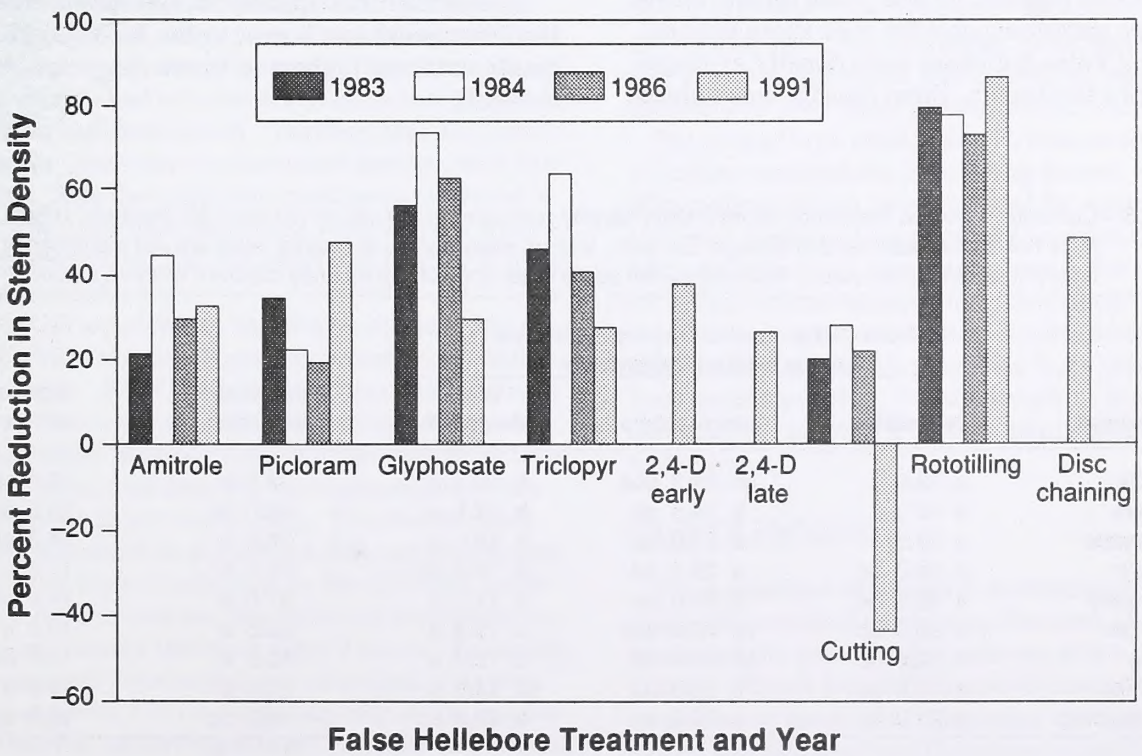

Figure 1—Percent reduction of false hellebore stem density from 1982 to 1983, 1984, 1986, and 1991 by treatment.

34.2 percent in 1983, 22.1 percent in 1984, 19.5 percent in 1986, and 46 percent in 1991 (fig. 1).

Glyphosate: False hellebore stem density averaged 14.8/m² before treatment. Stem density was reduced 55.8 percent in 1983, 73.2 percent in 1984, 62.3 percent in 1986, and 28.5 percent in 1991 (fig. 1).

Triclopyr: False hellebore stem density averaged 22.3/m² before treatment. Stem density was reduced 45.4 percent in 1983, 63.8 percent in 1984, 40.6 percent in 1986, and 26.0 percent in 1991 (fig. 1).

2,4-D early: The 1991 data indicated a 37 percent reduction in estimated pretreatment false hellebore stem density (fig. 1).

2,4-D late: The 1991 data indicated a 25.5 percent reduction in estimated pretreatment stem density (fig. 1).

Mechanical Treatments

Hand cutting: False hellebore stem density averaged 14.2/m² before treatment. Stem density was reduced 19.7 percent in 1983, 27.3 percent in 1984, 21.2 percent in 1986, and increased 43 percent in 1991 (fig. 1). The overall average height of false hellebore plants in this study plot in 1991 was less than that of the initial population. Before treatment, stem heights averaged between 75 and 100 cm; 1 year after treatment, stem heights averaged only 35 to 50 cm. No flowers were produced the year after treatment, but about 50 percent of the plants produced flowers the second year after treatment. Four years after cutting, the average plant height was between 50 and 75 cm (plants inside the plot were noticeably shorter than those outside).

Rototilling: False hellebore stem density averaged 21.7/m² before treatment. Stem density was reduced 79.2 percent in 1983, 78.2 percent in 1984, 73.3 percent in 1986, and 87 percent in 1991 (fig. 1).

Disc chaining: The 1991 data indicated a 48 percent reduction in false hellebore pretreatment stem densities as estimated from composite baseline stem density (fig. 1).

By 1991 all treatments were statistically more effective than the hand cutting, the herbicides were not significantly different from each other, and the rototilling was significantly more effective than all other treatments except for disc chaining and picloram ($p < 0.001$).

Community Response Based on Nested Frequency and Species Richness

For the majority of the treatments (2,4-D early, 2,4-D late, amitrole, triclopyr, glyphosate, and hand cutting) the community response was similar. The pattern seemed to be a high score for desirable species, an intermediate to high score for intermediate species, and a low score for less desirable species (table 3; fig. 2). The picloram treatment had the highest score for desirable species and low scores for intermediate and less desirable species. The rototill treatment had a low score for desirable species, a relatively high score for intermediate species, and an intermediate score for less desirable species. The disc chain treatment had an intermediate score for desirable species, a low score for intermediate species, and an intermediate score for less desirable species.

Species richness (number of species occurring in the treatment) was lowest in the 2,4-D and rototill treatments and highest in the triclopyr treatment (table 3).

Table 3—Cumulative nested frequency scores, stem density reduction, and species richness for the early 1980's false hellebore treatments in Boulger Canyon. Values preceded by the same letter are not significantly different within a row; values followed by the same letter are not significantly different within a column

Treatment	Cumulative nested frequency scores for recovered community			Percent stem reduction	Species richness
	Desirable	Intermediate	Less desirable		
Amitrole	a 38.0 c	ab 24.3 bcd	b 10.3 a	32.5 b	15.8 abc
Picloram	a 42.0 c	b 14.5 ab	b 12.5 a	46.0 bc	15.0 abc
Glyphosate	a 39.5 c	b 22.0 bc	b 10.0 a	28.5 b	14.3 abc
Triclopyr	a 34.0 bc	a 29.3 cd	b 16.0 ab	26.0 b	17.0 c
2,4-D early	a 33.3 bc	b 23.0 bc	c 11.3 a	37.0 b	14.0 ab
2,4-D late	a 26.0 ab	ab 20.5 abc	b 13.3 a	25.5 b	13.0 a
Cutting	a 32.5 bc	ab 22.5 bc	b 12.0 a	–43.0 a	16.0 bc
Rototilling	a 15.5 a	b 33.3 d	ab 24.0 c	87.0 c	13.0 a
Disc chaining	a 21.0 a	a 12.0 a	a 22.8 bc	48.0 bc	15.8 abc

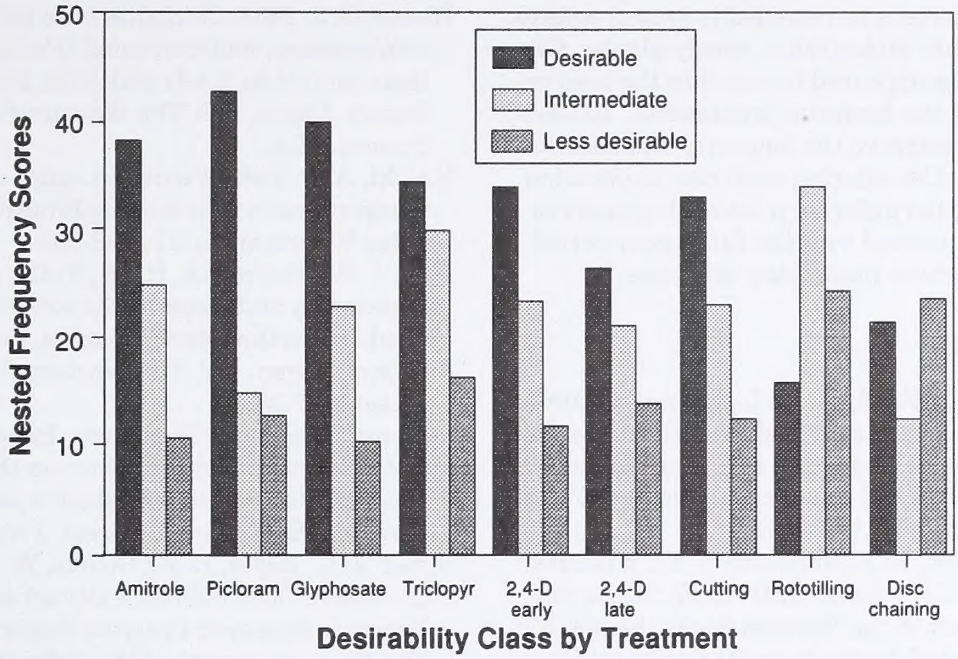

Figure 2—Community response after 9 years to control treatments for false hellebore by desirability class.

DISCUSSION

These data suggest that rototilling produced the most immediate and sustainable reduction of false hellebore. A possible disadvantage is that rototilling is limited to areas accessible by a tractor and to areas with a limited amount of rock in the top 20 cm of the soil profile. In addition, some form of reseeding will be required afterward, since the weedy vegetation that becomes established otherwise is little better than the initial false hellebore patch. Tarweed (*Madia glomerata*) was the dominant replacement species after this treatment. The disc chaining treatment produced a similar response; false hellebore stem density was reduced substantially, but the species replacing it were often undesirable.

The control achieved by herbicides appeared to be greatest within the first 2 posttreatment years, declining afterward. All of the herbicide treatments would likely have been enhanced by reseeding. A vigorous reseeding would probably suppress the recovering false hellebore stand and improve the composition of the posttreatment plant community. The results from this study indicated no significant differences between the degree of control achieved by the different herbicides ($\alpha = 0.05$); however, the picloram treatment reduced stem density the most after 9 years. Posttreatment community structure was also similar among these treatments with a large majority of the species being classified as having either desirable or intermediate qualities.

The cutting treatment did not appreciably control the stem density of false hellebore, although a reduction in canopy height and plant vigor was observed during the first years following treatment. A followup defoliation treatment may have killed these plants, which were already under apparent stress from the first treatment. The treatment appeared to have stimulated stem production by 1991; hand cutting was the only treatment that produced higher stem densities in 1991 than existed before treatment.

The lack of true replication in this study precludes definitive conclusions from being drawn; nor can specific applications be recommended for a variety of sites. However, because data relating to control of false hellebore are so limited, managers have little information on which to base management decisions. Data from this study may provide useful information for control efforts. The nearly 10-year data base helps evaluate treatment longevity. Further work in this area is necessary to provide a better understanding of control options.

CONCLUSIONS

Final selection of a control methodology should be made after carefully analyzing the costs of each treatment and the potential for recovery of the native community. Where logistically and financially feasible, rototilling or some other treatment that disrupts false hellebore's rhizome would appear to be the best alternative for control; however, after such a disturbance

these sites would have to be reseeded to protect against the invasion of other undesirable, weedy plants. Glyphosate treatments appeared to result in the best initial control among the herbicide treatments. Reseeding might greatly improve the longevity and success of this treatment. Considering herbicide application without reseeding, the picloram treatment appears to have had the best control over the full 9-year period and the most favorable community response.

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Herbicide and mechanical control treatments for false hellebore (*Veratrum californicum* Durand) were applied in the early 1980's at an alpine site in central Utah. Periodic data collection through 1991 indicated the treatments' relative effectiveness. The 1991 data also evaluated natural recovery of the understory plant community. Mechanical treatments were most effective when the rhizome was disrupted; however, the ensuing plant communities had a high density of weeds. Several herbicides also effectively controlled false hellebore, with fewer weeds in the understory afterward.

KEYWORDS: herbicides, weed control, mechanical methods, hand cutting, rotary cultivators, disc chaining

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